

CONTROLLED COPY NO. _____

**REVIEWED FOR
CLASSIFICATION**

UEO-1013

TCD 8/20/94
Initials Date
UNCLASSIFIED

**PADUCAH GASEOUS DIFFUSION PLANT
AND
PORTSMOUTH GASEOUS DIFFUSION PLANT
RADIOLOGICAL PROTECTION MANUAL
Revision 1**

**R. G. Carroll
T. A. Graben
M. W. Granus
J. F. Thompson**

**MMES/MMUS Consolidation
Additional Members**

**R. W. Dively
M. J. Eversole
S. E. Meiners**

November 1, 1994

Unclassified

ASSIGNMENT PAGE

UEO-1013

PGDP AND PORTS

GASEOUS DIFFUSION PLANTS

RADIOLOGICAL PROTECTION MANUAL

NOVEMBER 1, 1994

Manual No.: _____

Assigned To: _____
(Name) (Address)

Each person to whom a manual is assigned shall maintain it in proper order, inserting new or revised pages immediately upon their receipt and returning the receipt acknowledgement. In addition, each manual holder shall mark off the appropriate control issue number on the Issue Sheet in front of the manual when transmittals of revised pages are received. All changes, additions, and deletions to the distribution of this manual must be sent written memo to D. M. Lunsford, C-743, (502) 441-6411, Paducah Gaseous Diffusion Plant. When the manual holder transfers or terminates, or when the manual is no longer needed, it should be returned to the above-mentioned person.

RADIOLOGICAL PROTECTION MANUAL

| | <u>Page</u> |
|---|-------------|
| PREFACE | 3 |
| Chapter 1 RADIOLOGICAL PROTECTION PROGRAM | |
| IMPLEMENTATION | 5 |
| PART 1 Radiological Protection Manual | 7 |
| PART 2 Conduct of Radiological Operations | 8 |
| PART 3 ALARA Program | 9 |
| PART 4 Radiological Protection Organization | 9 |
| Chapter 2 RADIOLOGICAL STANDARDS | 13 |
| PART 1 Administrative Control Levels and Dose Limits | 15 |
| PART 2 Contamination Control and Control Levels | 16 |
| PART 3 Posting | 18 |
| Chapter 3 CONDUCT OF RADIOLOGICAL WORK | 25 |
| PART 1 Planning Radiological Work | 27 |
| PART 2 Work Preparation | 29 |
| PART 3 Entry and Exit Requirements | 31 |
| PART 4 Radiological Work Controls | 32 |
| PART 5 Evaluating Radiological Protection Performance | 33 |
| Chapter 4 RADIOACTIVE MATERIALS | 35 |
| PART 1 Radioactive Material Identification, Storage, and Control | 37 |
| PART 2 Release and Transportation of Radioactive Material | 39 |
| PART 3 Radioactive Source Controls | 41 |
| PART 4 Support Activities | 42 |
| Chapter 5 HEALTH PHYSICS SUPPORT OPERATIONS | 45 |
| PART 1 External Dosimetry | 47 |
| PART 2 Internal Dosimetry | 48 |
| PART 3 Respiratory Protection Program | 48 |
| PART 4 Handling Radiologically Contaminated Personnel | 49 |
| PART 5 Radiological Monitoring and Surveys | 50 |
| PART 6 Instrumentation Calibration and Performance Tests | 52 |

| | |
|---|---------------|
| Chapter 6 TRAINING AND QUALIFICATION | 55 |
| PART 1 General Requirements | 57 |
| PART 2 General Employee Radiological Training | 58 |
| PART 3 Radiological Worker Training | 59 |
| PART 4 Health Physics Technician Qualification | 59 |
| PART 5 Other Training | 61 |
| Chapter 7 RADIOLOGICAL RECORDS | 63 |
| PART 1 Requirements | 65 |
| PART 2 Employee Records | 66 |
| PART 3 Visitors Records | 67 |
| PART 4 Records Management | 67 |
| PART 5 Radiological Reporting | 68 |
| REFERENCES | 69 |
| GLOSSARY | 73 |

PREFACE

The Radiological Protection Manual is provided to:

1. Maintain a safe and compliant environment for all employees, visitors, and subcontractors.
2. Support the corporate mission of providing the optimum product to our customer.
3. Ensure the continued viability of the enterprise.

All personnel entering Gaseous Diffusion Sites (GDSs) are protected from hazards, including those associated with exposure to ionizing radiation and radioactive materials. Though occupational radiation exposures are maintained as low as is reasonably achievable (ALARA), it is accepted that any exposure involves some risk. This manual is provided to assist in the implementation of the Radiological Protection Program based on the following criteria:

1. There shall be no exposure to ionizing radiation or radioactive materials without commensurate benefit.
2. Personnel radiation exposures and the release of radioactive effluents shall be maintained as low as is reasonably achievable.
3. Radiological controls shall be maintained to ensure compliance with the requirements of Title 10 Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" and Part 835, "Occupational Radiation Protection".
4. Continuous improvement in the Radiological Protection Program shall be pursued to optimize the protection of employees, members of the general public, and the environment.

Programmatic responsibilities are as follows:

1. Line managers are responsible for those portions of the Radiological Protection Program that effect areas under their cognizance.
2. The Health Physics Manager shall administer the Radiological Protection Program and support the radiological activities of operating divisions and departments.
3. All personnel at GDSs must comply with and adhere to the Radiological Protection Policy, the Radiological Protection Manual, all Radiological Protection procedures, and facility policies and directives. In addition, personnel are

required to report violations they observe and suggest improvements to the Radiological Protection Program.

This manual applies to DOE and NRC regulated operations. Regulatory differences are addressed in the manual. This united approach is integral to radiological protection at GDSs. Each individual is responsible for maintaining his or her exposure to radiation and radioactive materials ALARA. Radiological concerns shall be addressed by supervision. Training programs shall be designed to promote understanding and safe radiological practices. Oversight shall be maintained to determine the effectiveness of radiological controls and techniques. Teamwork involving all employees provides the cornerstone of continued success.

Chapter 1 RADIOLOGICAL PROTECTION PROGRAM IMPLEMENTATION

| | <u>Page</u> |
|---|-------------|
| PART 1 Radiological Protection Manual | 7 |
| 111 Purpose | 7 |
| 112 Manual Applicability and Control | 7 |
| 113 Personnel Responsibilities | 7 |
| PART 2 Conduct of Radiological Operations | 8 |
| PART 3 ALARA Program | 9 |
| PART 4 Radiological Protection Organization | 9 |
| 141 Health Physics Organization | 9 |
| 142 Radiological Protection Manager Qualifications | 10 |
| 143 Health Physics Functions and Staffing | 10 |
| 144 Relationship Between Health Physics Technicians and Workers | 11 |

Chapter 1 Radiological Protection Program Implementation

PART 1 Radiological Protection Manual

111 Purpose

This Radiological Protection Manual provides guidance for the implementation, operation, assessment, and oversight of the GDSs' Radiological Protection Policy. This Manual and facility procedures define the Radiological Protection Program, assure the intent of the policy is met, and compliance with regulatory requirements.

112 Manual Applicability and Control

This Manual establishes practices for the conduct of radiological protection activities at GDSs. The requirements of this Manual apply to all individuals who enter, perform work, or visit GDSs.

This Manual is a living document, not a substitute for regulations. It is intended to be consistent with relevant statutory and regulatory requirements and shall be revised whenever necessary to ensure such consistency.

In those cases where subcontractors are used to conduct activities at GDSs the application and reference of this Manual are required. The Radiological Protection Manager shall be included in the review and concurrence process in these situations.

The requirements of this manual and related procedures may be preempted by facility Emergency Response Manual.

113 Personnel Responsibilities

All personnel should recognize that their actions directly affect the overall radiological safety and the continued operation of the GDSs. Professional behavior shall be displayed in Restricted Areas at all times. Only activities essential to supporting plant operation and activities authorized by management shall be conducted.

Personnel shall comply with the following radiological protection requirements:

1. Follow posted, written, and oral radiological protection instructions and procedures, including instructions on Radiological Work Permits.
2. Report personal physical or mental conditions that may adversely effect safe radiological performance.

3. Limit the amount of material taken into Contamination Control Zones and Contamination Areas to minimize radioactive waste and future decontamination.
4. Wear personnel monitoring devices where required by Radiological Work Permits, postings, procedures, or by health physics personnel.
5. Do not loiter in radiation areas.
6. Do not eat, drink, or use tobacco products in Contamination Control Zones, Contamination Areas, High Contamination Areas and Airborne Radioactivity Areas.
7. Properly utilize Personnel Protective Equipment and clothing when required.
8. Conduct required monitoring at Boundary Control Stations.
9. Follow or comply with "evacuate" and "stop work" orders from Health Physics personnel promptly.

PART 2 Conduct of Radiological Operations

1. Line managers are expected to be involved in the planning, scheduling and conduct of radiological work. Assurance of adequate radiological safety shall not be compromised to achieve production, remediation, or financial objectives.
2. Supervisors shall be knowledgeable of and receptive to radiological concerns.
3. Line managers shall periodically monitor work areas to observe personnel at work and to identify radiological deficiencies and concerns.
4. Managers, supervisors, and workers shall be involved in the development of accurate, clear, written procedures for performing radiological work. If during the use of procedures a written requirement cannot be responsibly followed, the work shall be stopped and guidance obtained from the immediate supervisor.
5. Supervisors and managers shall encourage the work force to identify radiological control deficiencies and concerns.
6. Managers and supervisors should establish the best working conditions feasible to encourage improved radiological control. Work conditions should be considered in planning work.

7. Conditions such as poor housekeeping that could cause or promote the spread of contamination or the loss of radioactive material control shall be identified and corrected on a priority basis.
8. The actions or presence of Health Physics personnel does not absolve the workers of their responsibility for proper radiological performance
9. Event investigation procedures shall specify reporting requirements in accordance with 10 CFR 835 Subpart N or 10 CFR 20 Subpart M as appropriate.

PART 3 ALARA Program

The ALARA Philosophy is a prerequisite of the Radiation Protection Policy. An ALARA Committee shall be appointed by the Plant Manager.

The ALARA Committee shall include managers and workers, technical support personnel, and the Health Physics Organization.

1. The ALARA Committee shall make recommendations to management to minimize radiation doses and exposures to radioactive material.
2. The Committee shall review reports of the evaluation of the design and construction of facilities and systems, planned major modifications and work activities, exposure, waste, and release minimization projects.
3. The Committee shall receive the results of applicable reviews and audits, and shall review the overall conduct of the Radiological Protection Program.
4. The Committee shall have the authority to delegate responsibilities to technical experts as the need for this assistance is recognized to assure program goals.

PART 4 Radiological Protection Organization

141 Health Physics Organization

1. The Health Physics Organization provides radiological protection support to the facility. To effectively function, the Health Physics Organization shall be independent of the organizations responsible for production or remediation and have an equivalent reporting level.
2. The Health Physics organization shall provide oversight and control the technical aspects of all program elements that affect radiological protection.

3. The Radiological Protection Manager, directs the Health Physics Organization and is responsible for establishment of the Radiological Protection Program.
4. The Radiological Protection Manager shall have the authority to deny access to "Restricted" Areas for personnel who do not adhere to radiological protection requirements.
5. The Radiological Protection Manager shall have technical oversight of all radiological protection procedures with the authority to oversee, stop radiological work, or subcontract the services, as necessary, to maintain the integrity of the radiological protection program.
6. The Radiological Protection Manager shall have direct access to the Plant Manager.

142 Radiological Protection Manager Qualifications

1. The Radiological Protection Manager shall have the technical competence and experience to establish radiological protection programs and the supervisory capability to direct the implementation and maintenance of radiological protection programs.
2. The Radiological Protection Manager should have a minimum of a bachelor's degree in science or engineering, including formal training in radiological protection or the equivalent and meet the equivalent qualifications as stated in ANSI N3.1, (1987).
3. Management should provide persons assigned to or being considered for the Radiological Protection Manager a structured program leading to certification by the American Board of Health Physics.

143 Health Physics Functions and Staffing

1. The senior staff of the Health Physics Organization should include health physicists and other personnel with four-year degrees in science or engineering or equivalent experience.
2. Radiological Support personnel that provide health physics and radiological engineering, dosimetry, bioassay, independent oversight, instrumentation and calibration functions shall have technical qualifications pertinent to their assigned duties.

3. All Health Physics personnel should be encouraged to pursue registration by the National Registry of Radiation Protection Technologists (NRRPT).
4. A continuing education program shall be established. Preparation and maintenance or certification by the American Board of Health Physics for senior and professional staff members is encouraged.

144 Relationship Between Health Physics Technicians and Workers

Health Physics Technicians and their supervisors perform the functions of assisting and guiding workers in the radiological aspects of the job.

1. Radiological workers should be sufficiently qualified to recognize the symptoms of deteriorating radiological conditions and seek advice from Health Physics Technicians and their supervisors.
2. Health Physics Technicians and their supervisors shall have the responsibility and authority to stop radiological work or mitigate the effect of an activity if they suspect that the initiation or continued performance of a job, evolution, or test will result in the violation of radiological protection standards.
3. All personnel shall have the responsibility or authority to stop any work that could result in imminent danger or unacceptable risk. Stop work authority shall be exercised justifiably and responsibly.

Chapter 2 RADIOLOGICAL STANDARDS

| | <u>Page</u> |
|--|-------------|
| PART 1 | |
| Administrative Control Levels and Dose Limits | 15 |
| 211 Administrative Control Level | 15 |
| 212 Radiological Worker Dose Limits | 15 |
| 213 Members of the Public and Minors Dose Limits | 16 |
| 214 Embryo/Fetus Dose Limits | 16 |
| PART 2 | |
| Contamination Control and Control Levels | 16 |
| 221 Administrative and Engineering Controls | 16 |
| 222 Personnel Contamination Control | 16 |
| 223 Contamination Control Levels | 16 |
| 224 Airborne Radioactivity Control Levels | 17 |
| PART 3 | |
| Posting | 18 |
| 231 Posting Requirements | 18 |
| 232 Posting Controlled Areas | 18 |
| 233 Posting Restricted Areas | 19 |
| 234 Posting Radiation Areas | 19 |
| 235 Posting Contamination Control Zones | 19 |
| 236 Posting Contaminated and Airborne Radioactivity Areas | 19 |
| 237 Posting Radioactive Material Areas | 19 |
| Table 2-1 Summary of Dose Limits | 20 |
| Table 2-2 Summary of Contamination Values | 21 |
| Table 2-3 Criteria for Posting Radiation Areas | 22 |
| Table 2-4 Criteria for Posting Contamination Areas | 23 |
| Table 2-5 MMUS DAC and Airborne Radioactivity Posting Levels | 24 |

Chapter 2 RADIOLOGICAL STANDARDS

PART 1 Administrative Control Levels and Dose Limits

The objective is to maintain personnel radiation exposure well below regulatory dose limits. To accomplish this objective, challenging numerical Administrative Control Levels are established at levels below the regulatory limits to administratively control and help reduce individual and collective radiation dose.

The committed effective dose equivalent is used to assign internal dose received by personnel.

211 Administrative Control Level

An Administrative Control Level of 500 mrem per year total effective dose equivalent per person is established. In order for an individual to exceed an Administrative Control Limit the following is required:

- a. Receipt of occupational total effective dose equivalents for previous and current years;
- b. Approval by the Radiological Protection Manager;
- c. Approval by the Plant Manager.

212 Radiological Worker Dose Limits

1. Dose limits are provided in Table 2-1 and shall not be exceeded. These limits are consistent with the "Radiation Protection Guidance to Federal Agencies for Occupational Exposure" signed by the President.
2. Radiological workers may receive occupational exposure as a radiological worker if they:
 - a. Provide record of current approved Radiological Worker training;
 - b. Receive site-specific Radiological Worker training;
 - c. Provide NRC Form 4 or equivalent and written estimates for current year, when records are not immediately available.
3. Personnel dosimetry shall be required for radiological workers who are expected to receive an annual external whole body dose greater than 100 mrem or an annual dose to the extremities, lens of the eye or skin greater than 10 percent of the corresponding limits specified in Table 2-1.

213 Members of the Public and Minors Dose Limit

Members of the public and minors in the Controlled Area shall be limited to an annual radiation dose of 100 mrem total effective dose equivalent and monitored if expected to exceed 50 mrem.

214 Embryo/Fetus Dose Limits

After a female radiological worker voluntarily notifies the Medical Department in writing that she is pregnant, for the purposes of fetal/embryo dose protection, she is considered a declared pregnant worker. The total effective dose equivalent limit for the embryo/fetus from conception to birth (entire gestation period) is 500 mrem. She will be monitored if expected to exceed 50 mrem during the gestation period.

PART 2 Contamination Control and Control Levels

221 Administrative and Engineering Controls

Control of radioactive contamination is achieved by using engineering controls and worker performance to contain contamination at the source. Priority shall be given to control contamination at the source and minimize the number of contaminated areas.

222 Personnel Contamination Control

1. Personnel exiting Contamination Control Zones or Contamination Areas shall properly monitor for contamination.
2. Monitoring for contamination shall be performed using equipment that under laboratory conditions can detect total contamination of at least the values specified in Table 2-2.
3. Personnel finding detectable contamination on their skin or personal clothing shall promptly notify their supervision who will notify Health Physics as required. Personnel field decontamination efforts shall be performed as directed by Health Physics.

223 Contamination Control Levels

1. Contamination Control Zones shall be established as a buffer area to minimize the potential for spread of contamination to unrestricted areas.
2. A surface shall be considered contaminated if removable radioactivity detected is above the levels in Table 2-2.

3. Areas with removable contamination levels below Table 2-2 values but with surfaces exceeding the values of Table 2-2 for total contamination shall be posted as "Fixed Contamination Areas" unless:
 - a. The affected area is covered with contrasting fixative coatings approved by the Radiological Protection Manager;
 - b. Health Physics performs periodic radiological surveys to detect contamination that may become removable over time;
 - c. The affected surface is permanently marked or stenciled as "Fixed Contamination";
 - d. A formal inventory is maintained of Fixed Contamination Areas;
 - e. Removable contamination is reduced to below the values of Table 2-2 for removable contamination, and below detectable levels, if practical, before the fixative coating is applied; and
 - f. Methods for identification and maintenance of fixed contamination areas are implemented.
4. Fixed Contamination Areas shall be established and access controlled if unrestricted access is likely to result in a total effective dose equivalent to any person greater than 100 mrem in one year at 1 meter.
5. Soil contamination areas shall be posted in accordance with Table 2-4 and controls established.

224 Airborne Radioactivity Control Levels

1. Use of engineering and administrative controls to reduce the potential for internal exposure should be evaluated before allowing personnel, with or without respiratory protection, to enter areas with airborne radioactivity.
2. Occupied areas with airborne concentrations of radioactivity that are likely to be greater than, 10 percent of a Derived Air Concentration or 50 microgram/ cubic meter for soluble uranium shall be posted, as required. Values of Derived Air Concentrations for radionuclides of concern are provided in Table 2-5.

20 NOTE: Values stated in Table 2-5 were developed using the guidance in 10 CFR Appendix B Table 1 for mixtures of radionuclides and published in UEO-1003, "Uranium Enrichment Air Monitoring Technical Basis Document" which was developed for DOE.

PART 3 Posting

231 Posting Requirements

1. Radiological posting shall be used to alert personnel to the presence of radiation and radioactive materials and to aid them in minimizing exposures and preventing the spread of contamination.
2. Signs shall contain the standard radiation symbol colored purple, magenta, or black on a yellow background. Lettering shall be either purple, magenta, or black.
3. Areas shall be posted to signify actual or potential radiological conditions.
4. Postings should be maintained in a legible condition and updated based upon the results of the most recent surveys.
5. If contamination, radiation, and/or airborne activity exists in the same area, each condition shall be identified on the posting.
6. Entrance points to restricted areas should state basic entry requirements, such as dosimetry, Radiological Work Permit (RWP), and respiratory protection required.
7. Entrance points to Contamination Control Zones should be posted to indicate company issued clothing and shoes are required, along with the words "Caution, Contamination Control Zone".
8. Rope, tape, chain and similar barriers used to designate the boundaries of posted areas shall be yellow and magenta or purple in color.
9. Physical barriers should be placed so that they are clearly visible from all directions and at various elevations. They should not be easily walked over or under, except at identified access points. These barriers shall be set up such that they do not impede the intended use of emergency exits or evacuation routes.
10. Posting of doors should be such that the postings remain visible when doors are open or closed.
11. Yellow and magenta materials shall not be used for purposes other than radiological control.

232 Posting Controlled Areas

The Controlled Area shall be posted appropriately as designated by the Plant Managers.

233 Posting Restricted Areas

Restricted Areas that require TLDs for entry shall be posted.

234 Posting Radiation Areas

1. Areas shall be posted to alert personnel to radiation in accordance with Table 2-3.
2. RWP requirements shall be included either on or in conjunction with the posting.

235 Posting Contamination Control Zones

Contamination Control Zones shall be established within Restricted Areas to provide a buffer to minimize the spread of contamination. Contamination Control Zones shall be posted to alert personnel to contamination in accordance with Table 2-4.

236 Posting Contaminated and Airborne Radioactivity Areas

1. Areas shall be posted to alert personnel to contamination in accordance with Table 2-4.
2. RWP requirements shall be included either on or in conjunction with each posting as applicable.
3. Typical Derived Air Concentration (DAC) values are found in Table 2-5.

237 Posting Radioactive Material Areas

1. Areas where radioactive material is used or stored shall be posted "Caution Radioactive Material".
2. Posting for Radioactive Material Areas is not required when the radioactive material is inside a Contamination Control Zone, Contamination, Radiation, or Airborne Radioactivity Area.
3. Requirements for labeling radioactive material are contained in Chapter 4.

Table 2-1 Summary of Dose Limits

| TYPE OF EXPOSURE | ANNUAL LIMIT Total Effective Dose Equivalent |
|--|---|
| Radiological Worker: Whole Body (internal + external) | 5 rem |
| Radiological Worker: Lens of Eye | 15 rem |
| Radiological Worker: Extremity (hands and arms below the elbow; feet and legs below the knees) | 50 rem |
| Radiological Worker: Any organ or tissue (other than lens of eye) and skin | 50 rem |
| Declared Pregnant Worker: Embryo/Fetus | 0.5 rem for gestation period |
| Minors (under age 18): Whole body (internal + external) | 0.1 rem |
| Visitors* and public: Whole Body (internal + external) | 0.1 rem |

* Applies to visitors who have not completed approved Radiological Worker Training.

Notes:

1. Internal dose to the whole body shall be calculated as committed effective dose equivalent. The committed effective dose equivalent is the resulting dose committed to the whole body from internally deposited radionuclides over a 50-year period after intake.
2. Background, therapeutic and diagnostic medical exposures shall not be included in either personnel radiation dose records or assessment of dose against the limits in this Table.
3. See Article 541 for skin dose assessments.

Table 2-2 Summary of Contamination Values

| NUCLIDE (See Note 1) | REMOVABLE (dpm/100 cm ²) (Note 2) | TOTAL (FIXED + REMOVABLE) (dpm/100 cm ²) |
|--|---|--|
| U-nat, U-235, U-238, and associated decay products, Transuranic $\leq 2\%$ by alpha activity | 1,000 | 5,000 |
| Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 Transuranics $\geq 8\%$ by alpha activity | 20 | 500 |
| Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 | 200 | 1,000 |
| Transuranic modified materials containing > 2% and less than 8% transuranics by alpha radioactivity | 200 | 1,000 |
| Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and other noted above. | 1,000 | 5,000 |
| DOT Transportation removable contamination levels | 220 alpha 2200 beta-gamma | Not applicable |

Notes:

1. The values in this Table apply to radioactive contamination deposited on, but not incorporated into the interior of the contaminated item. Where contamination by both alpha and beta-gamma-emitting nuclides exists, the limits established for the alpha-and beta-gamma-emitting nuclides apply independently.
2. The amount of removable radioactive material per 100 cm² of surface area should be determined by swiping the area with a dry filter or soft absorbent paper while applying moderate pressure and then assessing the amount of radioactive material on the swipe with an appropriate instrument of known efficiency. For objects with a surface area less than 100 cm², the entire surface should be swiped, and the activity per unit area should be based on the actual surface area. Except for transuranics, Ra-228, Ac-227, Th-228, Th-230, Pa-231 and alpha emitters, it is not necessary to

use swiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual contamination levels are below the values for removable contamination.

Table 2-3 Criteria for Posting Radiation Areas

| AREA | DOSE RATE CRITERIA | POSTING |
|---|--|--|
| Radiation Area measured at 30 cm | $> 0.005 \text{ rem/hr}$ and $\leq 0.1 \text{ rem/hr}$ | "CAUTION, RADIATION AREA" "TLD and *RWP Required for Entry" |
| High Radiation Area measured at 30 cm | $> 0.1 \text{ rem/hr}$ and $\leq 500 \text{ rads/hr}$ | "DANGER OR CAUTION, HIGH RADIATION AREA" "TLD, Supplemental Dosimeter and RWP Required for Entry" |
| Very High Radiation Area at 1 m | $\geq 500 \text{ rads/hr}$ | "GRAVE DANGER, VERY HIGH RADIATION AREA" "SPECIAL CONTROLS REQUIRED FOR ENTRY" |

* Unless exempted by the Radiological Protection Manager.

Table 2-4 Criteria for Posting Contamination Areas

| AREA | CRITERIA | POSTING |
|--------------------------------|---|--|
| Contamination (Removable) | Levels > 1 time but \leq 50 times Table 2-2 values. | "CAUTION, CONTAMINATION AREA" "RWP Required for Entry" |
| High Contamination (Removable) | Levels > 50 times Table 2-2 values. | "CAUTION, HIGH CONTAMINATION AREA" "RWP Required for Entry" |
| Fixed Contamination * | Removable contamination < Table 2-2 levels and total contamination levels > Table 2-2 Column 3 values | "CAUTION, FIXED CONTAMINATION" OR "CAUTION, FIXED CONTAMINATION AREA" |
| Soil Contamination | > 10 CFR 20 Appendix B Table 2 Column 2 | "CAUTION, SOIL CONTAMINATION AREA" |
| Airborne Radioactivity | Concentrations > Posting Level column of Table 2-5 | "CAUTION, AIRBORNE RADIOACTIVITY AREA" "RWP Required for Entry" |
| Contamination Control Zone | Levels less than Table 2-2 removable column values with potential to exceed Table 2-2 removable column values | "CAUTION, CONTAMINATION CONTROL ZONE" |

* If conditions stated in Article 223 are satisfied, the area is exempt from area posting.

1. All contamination measurements are in units of dpm/100 cm².

Table 2-5 DAC and Airborne Radioactivity Posting Levels

| NUCLIDE (See Note 1) | DAC | POSTING LEVEL (Refer to note 2) | MONITORING |
|--|---------------------|--|---------------------|
| Gross Alpha (TRU free) based on U-234 | 5×10^{-10} | 1×10^{-11} | 3×10^{-12} |
| Gross Alpha (Modified TRU [8%]) based on Th-230 | 3×10^{-11} | 3×10^{-12} | 2×10^{-13} |
| Gross Alpha (TRU) based on Np-237 | 2×10^{-12} | 2×10^{-13} | 1×10^{-14} |
| Gross Beta-Gamma (Th-234/Pa-234, Class Y) | 1×10^{-7} | 1×10^{-8} | 4×10^{-10} |
| Tc-99, Class W Beta | 3×10^{-7} | 3×10^{-8} | 9×10^{-10} |

Notes:

1. All values listed with units of microcuries/milliliter ($\mu\text{Ci/ml}$)
2. Posting Levels are 10% of DAC or derived Administrative Control Limit (ACL) to control chemical toxicity from soluble uranium.
3. Monitoring levels are ACL's for occupied areas and require monitoring either by air sampling, bioassay or both.
4. DAC - Derived Air Concentration's listed are for the more limiting of 5 rem Committed Effective Dose Equivalent or 50 rem tissue or organ limit.
5. The values above are assumed as worst case, i.e., TRU is present in each mixture at the highest concentration per category as described below.
6. Area may be posted based on calculated DAC's from actual airborne radioactivity concentration data.

Chapter 3 CONDUCT OF RADIOLOGICAL WORK

| | <u>Page</u> |
|---------------|--|
| PART 1 | Planning Radiological Work |
| | 27 |
| 311 | Requirements |
| | 27 |
| 312 | Planning for Maintenance, Operations and Modifications |
| | 27 |
| 313 | Technical Work Documents |
| | 27 |
| 314 | Minimization of Internal Exposure |
| | 28 |
| PART 2 | Work Preparation |
| | 29 |
| 321 | Radiological Work Permits |
| | 29 |
| 322 | Use of Radiological Work Permits |
| | 29 |
| 323 | Pre-Job Briefings |
| | 30 |
| 324 | Personal Protective Equipment and Clothing |
| | 30 |
| PART 3 | Entry and Exit Requirements |
| | 31 |
| 331 | Controlled Areas |
| | 31 |
| 332 | Restricted Areas |
| | 31 |
| 333 | Visitor Entry Requirements |
| | 31 |
| 334 | Monitoring for Personnel Contamination |
| | 31 |
| PART 4 | Radiological Work Controls |
| | 32 |
| 341 | Requirements |
| | 32 |
| 342 | Logs and Communications |
| | 32 |
| 343 | Review of Work in Progress |
| | 32 |
| 344 | Stop Radiological Work Authority |
| | 32 |
| PART 5 | Evaluating Radiological Protection Performance |
| | 33 |
| 351 | Requirements |
| | 33 |
| 352 | Lessons Learned |
| | 33 |

Chapter 3 CONDUCT OF RADIOLOGICAL WORK

PART 1 Planning Radiological Work

311 Requirements

Technical requirements for the conduct of work, including construction, modifications, operations, maintenance and decommissioning, shall incorporate radiological criteria to ensure safety and shall incorporate ALARA principles.

312 Planning for Maintenance, Operations and Modifications

1. Maintenance, modification plans and procedures shall be reviewed to identify and incorporate radiological requirements, such as engineering controls, and dose and contamination reduction considerations. Line management is responsible for initiating this review, with the support and concurrence of the Health Physics Organization.
2. Trigger levels requiring formal radiological review of non-routine or complex work activities are as follows:
 - a. Estimated individual whole-body dose greater than 100 mrem;
 - b. Predicted airborne radioactivity concentrations that could result in individual intakes in excess of 40 DAC-hours;
 - c. Work area removable contamination greater than 100 times the values in Table 2-2;
 - d. Entry into areas where the dose rate exceeds 100 mrem/hour;
 - e. Potential radioactive releases to the environment that may exceed the guidelines specified in 10 CFR 20 Appendix B, Table 2.
3. Tasks with the potential to exceed the above trigger levels shall undergo a formal, documented radiological or ALARA review.
4. Radiological requirements identified as part of the above radiological review should be documented in the job plans, procedures or work packages.
5. Radiological tasks anticipated to exceed individual or collective dose criteria established in this Manual should be reviewed and approved by the ALARA Committee.

313 Technical Work Documents

1. Technical work documents, such as procedures, work packages, or job and research plans, should be considered to control hands-on work with radioactive materials.
2. Technical work documents used to control radiological work activities shall be reviewed and approved by the Health Physics Organization.
3. Radiological Control Hold Points should be incorporated into technical work documents to prevent radiation exposures in excess of Administrative Control Levels, the generation of airborne radioactivity, the loss of radioactive material control, and the release of radioactivity to the environment.

314 Minimization of Internal Exposure

The minimization and control of internal exposure should be conducted in accordance with the following controls:

1. Engineering controls, including containment of radioactive material at the source wherever practicable, should be the primary method of minimizing airborne radioactivity and internal exposure to workers.
2. Administrative controls, including access restrictions and the use of specific work practices designed to minimize airborne contamination or loss of contamination control should be used as the secondary method to minimize worker internal exposure.
3. When engineering and administrative controls have been applied and the potential for airborne radioactivity still exists, respiratory protection should be used to limit internal exposures.
4. Evaluation of workplace airborne radioactivity levels should be provided with continuous air monitors or air-samplers with expedited assessment and analysis of results.
5. Decontamination efforts to minimize intakes of radioactive materials should be considered when the use of respiratory protective equipment poses an undue stress to individuals performing work.
6. In the event that multiple hazard conditions exist and the associated risk from non-radiological hazards outweighs those of a radiological nature, then the Radiological Protection Manager may exempt the use of respiratory protective

equipment. The exemption may be made provided that engineering and administrative controls have been determined to be implausible or impractical.

PART 2 Work Preparation

321 Radiological Work Permits

The Radiological Work Permit (RWP) shall be the primary administrative mechanism by which radiological controls are established in areas of the facility. The RWP shall inform workers of area radiological conditions and entry requirements.

322 Use of Radiological Work Permits

1. RWPs shall be used to administratively control work and/or entry into Contamination Areas, Airborne Radioactivity Areas, or Radiation Areas. The Radiological Protection Manager may exempt the requirement for a RWP in certain Radiation Areas.
2. Job-specific RWPs shall be used to control non-routine operations or work in areas with changing radiological conditions. The job-specific RWP shall remain in effect only for the duration of the job.
3. General RWPs may be used to control routine or repetitive activities, such as tours and inspections or minor work activities, in areas with stable radiological conditions.
4. An RWP shall be issued to control radiological work in localized benchtop areas, containments, laboratory fume hoods, sample sinks, and gloveboxes located in areas that are otherwise contamination free.
5. Radiological surveys shall be routinely reviewed to evaluate adequacy of RWP requirements. RWPs shall be updated if radiological conditions change to the extent that protective requirements need modification.
6. Job-specific RWPs should be posted at the access point to the applicable radiological work area.
7. General RWPs may be posted at the access point and/or centralized location
8. Prior to initial entry to the area and after any revisions to the RWP workers shall sign that they have had the opportunity to read the RWP and ask questions if its provisions are not understood.

9. Worker pocket or electronic dosimeter readings, if required, shall be recorded in a format that directly correlates worker dosimeter and RWP information.

323 Pre-Job Briefings

Pre-job briefings when required by RWP shall be held prior to the conduct of work anticipated to exceed the Radiological Review trigger levels. The pre-job briefing shall alert personnel to the ALARA and associated radiological control requirements for specific tasks.

1. Pre-job briefings shall be conducted by the cognizant work supervisor unless otherwise specified.
2. Workers and supervisors directly participating in the job, cognizant Health Physics personnel, and representatives from involved support organizations shall attend a briefing.
3. A summary of the topics discussed and attendance at the pre-job briefing shall be maintained as part of the RWP documentation.

324 Personal Protective Equipment and Clothing

1. Personnel shall wear protective clothing during the following activities:
 - a. Handling of contaminated materials with removable contamination in excess of Table 2-2 levels;
 - b. Work in Contamination, High Contamination and Airborne Radioactivity Areas;
 - c. As directed by Health Physics on the RWP.
2. Reusable protective equipment or clothing designated for radiological control shall be used only for radiological control purposes.
3. Protective clothing dress-out areas should be established directly adjacent to the work area, whenever practical. Workers should proceed directly to the radiological work area after donning Personal Protective Equipment and clothing.
4. The use of Personal Protective Equipment or clothing (including respiratory protection) beyond that required by health physics or safety personnel is contrary to ALARA and waste minimization practices and is discouraged.
5. In the event that multiple hazard conditions exist and the associated risk from non-radiological hazards outweighs those of a radiological nature, then the

1. 2. 3. 4.



1. 2. 3. 4.

Radiological Protection Manager may exempt the use of Personal Protective Equipment or clothing.

PART 3 Entry and Exit Requirements

331 Controlled Areas

Successful completion of Visitor Orientation or General Employee Radiological Training is required for unescorted entry into the Controlled Area.

332 Restricted Areas

The minimum requirements for unescorted entry into Restricted Areas shall include the following:

1. Personnel dosimetry;
2. Radiological Worker training;

333 Visitor Entry Requirements

1. Visitors with a demonstrated need to enter a Restricted Areas may be permitted access if such access is controlled with a combination of training and/or the use of escorts trained for the specific area.
2. Visitors shall be prohibited from entering High Radiation Areas, High Contamination, and Airborne Radioactivity Areas, unless authorized by the Radiological Protection Manager.

334 Monitoring for Personnel Contamination

1. Personnel shall perform a whole-body frisk and frisk hand-carried items when exiting Contamination Control Zones and Contamination Areas, or as directed by Health Physics.
2. Where frisking cannot be performed at the exit from Contamination Areas due to high background radiation levels, personnel shall:
 - a. Remove all protective equipment and clothing at the exit;
 - b. Proceed directly to the nearest designated monitoring station;

PART 4 Radiological Work Controls

341 Requirements

1. Radiological work activities shall be conducted as specified by the RWP or, when applicable, controlling technical work documents.
2. Prerequisite conditions, such as tag-outs and system isolations, shall be verified before work is initiated.

342 Logs and Communications

1. Health Physics shall maintain logs to document actions taken, activities completed, and information necessary for event reconstruction.
2. Shift turnovers shall be performed by Health Physics personnel to maintain continuity of information relevant to radiological safety.
3. Workers shall keep Health Physics personnel informed of changes to activities that may affect radiological conditions.

343 Review of Work in Progress

1. As part of their normal work review, work supervisors should periodically review ongoing jobs to ensure prescribed radiological controls are being implemented.
2. Health Physics personnel should conduct tours of areas of ongoing work to review the adequacy of radiological work practices, posting and area controls.

344 Stop Radiological Work Authority

1. Health Physics Technicians and their supervisors, line supervision, and any worker have the authority and responsibility to stop radiological work activities on a job for any of the following reasons:
 - a. Inadequate radiological controls;
 - b. Radiological controls not being implemented;
 - c. Radiological Control Hold Point not being satisfied;
 - d. Any imminent danger associated with the work activity.
2. Stop radiological work authority shall be exercised judiciously and responsibly.
3. Once radiological work has been stopped, it shall not be resumed until proper radiological control has been reestablished.

4. When radiological work is stopped by Health Physics, resumption of work requires the approval of the Radiological Protection Manager.

PART 5 Evaluating Radiological Protection Performance

351 Requirements

A Performance Indicator Program shall be established to identify and review progress of efforts to improve the Radiological Protection Program. The Performance Indicators shall be reviewed annually to ensure continued effectiveness.

Critiques and analyses of the facts should reveal areas where improvements can be made or to identify methods to prevent the recurrence of undesired results.

352 Lessons Learned

Lessons learned are available from reports of radiological events. The Health Physics Organization, in conjunction with line management, should evaluate lessons learned, provide prompt distribution, and incorporate the lessons into the Health Physics Program, the radiological training program and related operations.

Chapter 4 RADIOACTIVE MATERIALS

| | <u>Page</u> |
|---------------|---|
| PART 1 | Radioactive Material Identification, Storage and Control |
| | 37 |
| 411 | Determination |
| | 37 |
| 412 | Radioactive Material Labeling |
| | 37 |
| 413 | Radioactive Material Packaging |
| | 37 |
| 414 | Radioactive Material Storage |
| | 38 |
| 415 | Environmental Conditions |
| | 38 |
| PART 2 | Release and Transportation of Radioactive Material |
| | 39 |
| 421 | Release from Contamination Control Zones or Radiologically Contamination Areas |
| | 39 |
| 422 | Control of On-site Transfers of Radioactive Material |
| | 39 |
| 423 | Unconditional Release from Controlled Areas |
| | 40 |
| 424 | Off-Site Removal and Transportation of Radioactive Material |
| | 40 |
| 425 | Vehicle Monitoring |
| | 41 |
| PART 3 | Radioactive Source Controls |
| | 41 |
| 431 | Sealed and Unsealed Sources |
| | 41 |
| PART 4 | Support Activities |
| | 42 |
| 441 | Personal Protective Equipment and Clothing |
| | 42 |
| 442 | Decontamination |
| | 42 |
| 443 | Vacuum Cleaners and Portable Air-Handling Equipment |
| | 43 |
| 444 | Radiation Generating Devices |
| | 43 |
| 445 | Construction and Restoration Projects |
| | 43 |

Chapter 4 RADIOACTIVE MATERIALS

PART 1 Radioactive Material Identification, Storage, and Control

411 Determination

Equipment and materials exiting Contamination Control Zones, Contamination Areas or Airborne Radioactivity Area shall be considered to be contaminated until surveyed and released by Health Physics.

412 Radioactive Material Labeling

Radioactive or contaminated material outside Contamination Control Zones, Contamination Areas, or Radiation Areas shall be surveyed and labeled "Caution - Radioactive Material" by Health Physics.

1. Labeling shall be durable, clearly visible, and provide sufficient information that identifies radiological hazards.
2. Tails or product cylinders in transit to or stored in cylinder yards are exempt from labeling requirements.
3. Labels shall be removed or defaced prior to removal or disposal of empty uncontaminated containers to unrestricted areas.

413 Contaminated Material Packaging

Packaging of contaminated material shall be approved by Health Physics to minimize the spread of radioactive contamination. Considerations shall be given to the concerns of Nuclear Criticality and Transportation requirements. Radioactive materials packaged for transportation in commerce shall be packaged in accordance with 49 CFR and 10 CFR as applicable.

1. Material that is outside Contamination Control Zones or Contamination Areas and is confirmed or suspected of having removable radioactive contamination levels greater than Table 2-2 values shall be securely contained, as determined by Health Physics.
2. Material or equipment with removable contamination and sharp edges or projections should be taped or additionally protected to ensure package integrity.
3. Material with removable or potentially removable contamination levels in excess of 100 times Table 2-2 values should have additional packaging controls such as double-wrapping or the use of plastic bags inside containers.

4. Yellow plastic wrapping material should be used for packaging radioactive material. Yellow plastic sheets or bags shall not be used for non-radiological purposes.
5. The amount of combustible material used in packaging shall be minimized.

414 Radioactive Material Storage

1. Radioactive material shall be stored in a designated Radioactive Material Area.
2. Decontamination or disposal of radioactive material is the preferred alternative to long-term storage.
3. Each Radioactive Material Area shall be approved by Health Physics and posted prior to use.
4. Annual or more frequent reviews of each Radioactive Material Area, with emphasis on decontamination, movement of material to long-term storage locations and disposal of unneeded material shall be conducted.
5. In cases where outdoor storage is necessary, the integrity of containers used shall be ensured to prevent degradation from weathering and subsequent release of radioactive material.
6. Radioactive material shall be stored in a manner that reduces combustible loading. Flammable or combustible materials should not be stored adjacent to Radioactive Material Areas. Fire protection measures, such as smoke detectors, water sprinklers and fire extinguishers, shall be considered when establishing a Radioactive Material Area.
7. Items stored in Radioactive Materials Areas shall be packaged such that outside surfaces can be monitored for release (e.g., outside surfaces does not consist of wood or cardboard).

415 Environmental Conditions

Inclement weather or other environmental conditions may disrupt radiological controls. If that occurs, the following actions shall be considered:

1. The use of covers, wind screens and runoff collection basins to preclude the inadvertent spread of radioactive material.
2. Provisions for work site personnel to assemble and be monitored prior to release or reestablishment of work

3. Evaluation of work area to determine if a need exists for modified work controls or decontamination.

PART 2 Release and Transportation of Radioactive Material

Release surveys shall only be performed by qualified Health Physics personnel.

421 Release from Contamination Control Zones or Radiologically Contaminated Areas

1. Items and material being released from Contamination Control Zones or radiologically contaminated areas shall be surveyed prior to removal.
2. Material and equipment with contamination levels greater than Table 2-2 values shall be labeled and packaged prior to removal from the area.
3. Items and material being released shall be promptly removed from Contamination Control Zones or radiologically contaminated areas after being surveyed.
4. Table 2-2 contamination values shall be used to control packaging and labeling limits for on-site transfer of radioactive material or equipment.
5. Surveys for the release of equipment and materials shall be conducted incorporating techniques to detect both removable and fixed contamination.
6. Items, with inaccessible surfaces, which were located in known or suspected contamination areas and had the potential to become contaminated at levels likely to exceed Table 2-2 values shall be treated as contaminated, unless the items are dismantled and monitored or special survey techniques are used to survey all surfaces.

422 Control of On-site Transfers of Radioactive Material

1. Radioactive material being moved from one Restricted Area to another Restricted Area with equivalent level of radiological controls may be exempt from the Health Physics survey requirements in Article 421 above provided:
 - a. The material is properly packaged;
 - b. The material is identified as radioactive material; and
 - c. The transfer is performed in accordance with written procedures. These procedures shall include requirements to ensure appropriate monitoring and control of the radioactive material and shall be approved by Health Physics

2. Radioactive material in transit shall be continuously attended by a qualified Radiological Worker.

423 Unconditional Release from Controlled Areas

1. Material and equipment with contamination levels greater than Table 2-2 values shall not be unconditionally released from the Controlled Area.
2. Items and material shall be surveyed prior to release from the Controlled Area except as authorized by the Radiological Protection Manager.
3. Material being released shall be evaluated for contamination under any coatings and inaccessible surfaces.
4. Material being released shall be promptly removed from the Controlled Area after documentation of the radiological survey.
5. Records for release of potentially contaminated materials should describe the property, date of last survey, identity of the person who performed the survey, type and identification number of the survey instrument used, and survey results.

424 Off-Site Removal and Transportation of Radioactive Material

Title 49 CFR describe the requirements for inspecting and surveying packages, containers, and transport conveyances prior to the off-site shipment. Title 10 CFR, Part 20 states the requirements for receipt of Radioactive Material.

1. Radioactive material shipments or other material destined for off-site use shall be surveyed by Health Physics prior to release.
2. Radioactive material shipments from off-site shall be surveyed by Health Physics prior to acceptance.
3. DOT transportation removable contamination limits for off-site shipments are listed in Table 2-2.
4. Health Physics approval is required prior to placing radioactive material in or on non-GDSs vehicles, except shipments made under 49 CFR.

425 Vehicle Monitoring

1. Vehicles shall not be taken into Contamination Control Zones or Contamination Areas without Health Physics authorization.

2. All vehicles exiting the Contamination Control Zones or Contamination Areas shall be surveyed by Health Physics.
3. All vehicles exiting the Controlled Area are subject to Health Physics monitoring.
4. Vehicle monitoring frequencies and criteria shall be established.
5. Vehicles found to have removable contamination greater than Table 2-2 levels shall be removed from service and decontaminated.
6. Vehicles found to have fixed contamination greater than Table 2-2 levels shall be controlled and shall not be removed from Controlled Areas without specific Health Physics authorization.
7. Health Physics approval is required for entry of Non-GDS vehicles into Restricted Areas.

PART 3 Radioactive Source Controls

431 Sealed and Unsealed Sources

1. Health Physics shall maintain, or provide oversight for accountability records for radioactive sources.
2. Source custodians shall be appointed to maintain radioactive source controls.
3. Source custodians shall notify Health Physics of changes in use, storage, transfer, disposal, or loss of a sources.
4. Sealed source integrity testing shall be performed at least every 6 months or whenever damage might have occurred unless exempted by the certification authority.
5. Labels used to identify sources shall identify the radionuclide, activity, date of assay, source model and serial number, and source custodian.
6. Procurement of radioactive sources shall be coordinated with Health Physics.
7. Receipt surveys of radioactive source shall be performed by Health Physics.
8. Sources, including radiography sources, shall not be brought on-site by external organizations without the prior written approval of Health Physics.

PART 4 Support Activities

441 Personal Protective Equipment and Clothing

1. Radiological controls shall be the same for non-anti-c company issued clothing and personal clothing.
2. Protective clothing for radiological control use shall be properly controlled and shall not be used for nonradiological purposes.
3. Protective clothing for radiological control use shall not be modified.
4. Normal company-issued personal protective equipment and clothing (e.g., blue coveralls and company shoes) shall not be stored with personal street clothing.
5. Personal Protective Equipment shall be inspected, surveyed and laundered, as applicable, prior to re-issuance.
6. Clothing and equipment should be screened by Laundry personnel to segregate those that are damaged, present special handling problems, or require disposal.
7. Laundered anti-c clothing should be surveyed using statistically representative sampling and should meet the following criteria prior to reuse:
 - a. Beta-gamma radioactivity less than 20,000 dpm/100 cm²;
 - b. Alpha radioactivity less than 1,000 dpm/100 cm²;
 - c. TRU alpha radioactivity less than 1,000 dpm/100 cm².

442 Decontamination

1. Radiological Work Permits are required for decontamination efforts as specified by Health Physics.
2. Work preplanning should include consideration of the handling, temporary storage, and decontamination of materials and equipment.
3. Decontamination methods should be selected based upon their effectiveness, hazardous properties, amount of waste generated and ease of disposal.

443 Vacuum Cleaners and Portable Air-Handling Equipment

1. Vacuum cleaners and portable air-handling equipment used in ALL Radiological Areas shall be equipped with High-Efficiency Particulate Air (HEPA) filters, labeled as Radioactive Material, and controlled by an RWP. Units shall be completely sealed when work is complete (hose ends).
2. Nuclear Criticality Safety shall approve all devices used for fissile material.

444 Radiation Generating Devices

1. Special considerations associated with the use of radiation generating devices include the presence of extremely high dose rates and the potential for uncontrolled exposures. Operation of these devices requires stringent physical and administrative controls to prevent overexposure to operating and support personnel and those in adjacent work areas.
2. Health Physics shall establish the radiological protection requirements for radiography devices.

445 Construction and Restoration Projects

1. For construction and restoration projects; including decontamination and decommissioning (D&D), remedial action, or other actions involving materials that may contain low levels of radioactivity; may present special problems and require facility- or program-specific control methods. Health and Safety Plans shall be developed to specify controls and facilitate resource planning for restoration programs. Health and Safety Plans developed for environmental restoration or construction projects shall be approved by the Radiological Protection Manager.
2. Radiological operations and work activities at construction and environmental restoration projects shall be conducted in accordance with this manual. These projects may require radiological considerations different from other activities governed by this manual. The Radiological Protection Manager has the responsibility to document and approve the technical equivalency of alternative requirements.

Chapter 5 HEALTH PHYSICS SUPPORT OPERATIONS

| | <u>Page</u> |
|------------------|--|
| PART 1 | External Dosimetry |
| | 47 |
| 511 | Requirements |
| | 47 |
| 512 | Technical Requirements for External Dosimetry |
| | 47 |
| PART 2 | Internal Dosimetry |
| | 48 |
| 521 | Requirements |
| | 48 |
| 522 | Technical Requirements for Internal Dosimetry |
| | 48 |
| PART 3 | Respiratory Protection Program |
| | 48 |
| 531 | Program Management |
| | 48 |
| 532 | Use of Respiratory Protection |
| | 48 |
| 533 | Half Face Respirators |
| | 49 |
| PART 4 | Handling Radiologically Contaminated Personnel |
| | 49 |
| 541 | Skin Contamination |
| | 49 |
| 542 | Contaminated Wounds |
| | 50 |
| PART 5 | Radiological Monitoring and Surveys |
| | 50 |
| 551 | Requirements |
| | 50 |
| 552 | Contamination Surveys |
| | 51 |
| 553 | Airborne Radioactivity Monitoring |
| | 51 |
| PART 6 | Instrumentation Calibration and Performance Tests |
| | 52 |
| 561 | Calibration |
| | 52 |
| 562 | Maintenance |
| | 53 |
| 563 | Calibration Facilities |
| | 53 |
| Table 5-1 | Non-Uniform Exposure of the Skin |
| | 54 |

Chapter 5 HEALTH PHYSICS SUPPORT OPERATIONS

PART 1 External Dosimetry

511 Requirements

1. Personnel dosimetry is required for personnel for entry into Restricted Areas, handling of radioactive material, and as determined by Health Physics.
2. Neutron dosimetry shall be required when personnel are likely to exceed 100 mrem annually from neutron radiation.
3. The need for extremity and/or supplemental dosimetry shall be determined by Health Physics.
4. Dosimetry devices shall be worn only by those to whom the dosimeters were issued.
5. Personnel dosimeters shall be returned for processing as scheduled or upon request, and individuals shall be prohibited from reentry into Restricted Areas, until dosimeters are reissued.
6. Personnel shall wear dosimetry devices as directed by Health Physics.
7. Personnel shall not expose their dosimeters to security x-ray devices, excessive heat, or medical sources of radiation.
8. A person whose dosimeter is lost, damaged, or contaminated shall place work in a safe condition, immediately exit the area and report to Health Physics for investigation. Re-entry of the person into Restricted Areas shall not be made until a review has been conducted and Health Physics has approved reentry.
9. There should be no concurrent monitoring permitted at GDS, without Health Physics approval.

512 Technical Requirements for External Dosimetry

1. The External Dosimetry Program shall be accredited and maintained.
2. An External Dosimetry Technical Basis Document describing fundamental program elements shall be maintained.

PART 2 Internal Dosimetry

521 Requirements

1. Personnel whose enter Contamination Control Zones, contamination areas, or Airborne Radioactivity Areas shall participate in a bioassay program when they are likely to receive intakes resulting in a committed effective dose equivalent greater than or equal to 100 mrem in a year.
2. Personnel shall participate in follow-up bioassay monitoring when their bioassay results indicate an intake of radioactive material, as determined by Health Physics.
3. Personnel whose routine duties may involve exposure to surface or airborne contamination shall be required to participate in the bioassay program.
4. Personnel shall submit bioassay samples, such as urine or fecal samples, and participate in Invivo monitoring, as required by the bioassay program.
5. Personnel should be notified promptly of positive bioassay results and the results of dose assessments and subsequent refinements.

522 Technical Requirements for Internal Dosimetry

An Internal Dosimetry Technical Basis Document describing fundamental program elements shall be maintained.

PART 3 Respiratory Protection Program

531 Program Management

The Radiological Respiratory Protection program shall consist of written procedures regarding selection, fitting, issuance, maintenance and testing. The protection factors for respirators shall be applied as specified in 10 CFR 20, Appendix A.

532 Use of Respiratory Protection

Radiological respiratory protection requirements shall be specified by Health Physics. Personnel using respiratory protection shall:

1. Be issued respirators only upon verification of medical approval, training and fit testing.

2. Perform fit checks of their respirators to ensure a proper seal before entering areas requiring respirator use.
3. Not have facial hair interfering with proper respirator seal.
4. Use corrective lenses, if needed, that are approved for respirators.
5. Be instructed to leave the work area when experiencing respirator difficulties.
6. Be trained on proper emergency procedures when using respiratory protection equipment.

533 Half Face Respirators

Half-face respirators shall not be used for protecting workers from radioactive materials.

PART 4 Handling Radiologically Contaminated Personnel

541 Skin Contamination

1. Survey techniques shall be established to determine the extent of skin contamination.
2. Personnel shall immediately notify Health Physics upon detection of skin contamination.
3. The extent of skin contamination should be determined prior to initiating decontamination procedures.
4. Skin decontamination methods shall be established for facility-specific radionuclides.
5. Skin abrasion shall be avoided during the field decontamination process.
6. Intrusive decontamination methods, such as tissue removal, shall only be performed by medical personnel as approved by facility Medical Director.
7. Personnel with skin contamination that triggers the need for dose assessment should be informed of the initial dose estimate to their skin as soon as practicable.
8. Skin dose assessment and recording.
 - a. For DOE requirements see Table 5-1.

- b. For NRC requirements dose assessments shall be performed by Health Physics and the shallow dose equivalent recorded, when the estimated dose to the skin exceeds 100 mrem to any 1 cm².

542 Contaminated Wounds

1. Emergency medical care shall be administered immediately for injuries involving radioactive materials and takes precedence over radiological considerations.
2. Injured personnel **shall only** be counseled by the Radiological Protection Manager or designee and Medical professionals. Counseling should include the medical and radiological implications resulting from contaminated wounds that result in internal doses greater than 2 percent of the Table 2-1 limits.

PART 5 Radiological Monitoring and Surveys

551 Requirements

1. Monitoring which establishes personnel protection requirements shall only be performed by Health Physics personnel. Work in progress monitoring may be performed by qualified Radiological Workers.
2. Surveys shall be performed using calibrated instruments designed to detect the radiation types and quantities required.
3. Performance of surveys for radiation, contamination and airborne radioactive materials shall be according to procedures.
4. Instruments used to perform radiological surveys shall be response-checked daily or prior to use as specified in instrument use procedures.
5. Surveys should be performed before, during, and at the completion of work that has the potential for causing changes in levels of radiation and radioactivity.
6. Survey frequencies should be established based on potential or actual radiological conditions, probability of change in conditions, area occupancy and other factors.
7. Monitoring results should be made available to line management and used in support of pre- and post-job evaluations, ALARA planning, contamination control and the control of radiological conditions.
8. Monitoring data in each building or area should be compiled and reviewed by Health Physics supervision.

9. Radiation surveys should include dose rate measurements of the general area, dose rates at a distance of 30 centimeters from a source or surface of interest to evaluate potential whole body exposures, and dose rates on contact with potential sources of radiation where there is a potential for hands-on work.
10. Radiation survey results shall be reported in units of rem/hour.
11. Radiological surveys shall be documented on standard forms and contain information necessary to facilitate proper interpretation of the survey.

552 Contamination Surveys

1. Surveys for removable contamination shall be reported in units of disintegrations per minute per 100 cm² (dpm/100 cm²). Surveys of small items covering less than 100 cm², the results shall be reported in units of dpm per smear.
2. Large area wipes should be used to supplement standard smear techniques in areas generally assumed not to be contaminated. If an evaluation indicates that an area wiped is contaminated, a thorough contamination survey shall be performed. Large area wipes shall be reported in units of dpm/per area wiped.

553 Airborne Radioactivity Monitoring

Air monitoring equipment should be used in situations where airborne radioactivity levels can fluctuate and early detection of airborne radioactivity could prevent or minimize inhalation of radioactivity by personnel. Selection of air monitoring equipment should be based on the specific job being monitored. Air monitoring equipment includes portable and fixed air sampling equipment and continuous air monitors.

1. Portable air sampling equipment shall be used in occupied areas where, under normal operating conditions, a person is likely to receive an annual intake of 2 percent or more of the specified Annual Limit of Intake (ALI) values (40 Derived Air Concentration (DAC) hours).
2. Continuous air monitoring equipment should be installed in normally occupied areas where a person without respiratory protection is likely to be exposed to a concentration of radioactivity in air exceeding 1 DAC or where there is a need to alert potentially exposed workers to unexpected increases in the airborne radioactivity levels. Continuous air monitors should be capable of measuring 1 DAC when averaged over 8 hours (8 DAC-hours) under laboratory conditions.
3. Air sampling equipment should be positioned to measure air concentrations to which persons are exposed. If this cannot be achieved, a program of personal breathing-zone air sampling shall be initiated.

4. Air monitoring equipment shall be calibrated and maintained.
5. Air sample results should be evaluated as quickly as practicable, for evaluation of the need for respiratory protection, area evacuation (if necessary), worker intake and worker relief from respirator use.
6. Air sample results shall be reported in units of microcurie/milliliter ($\mu\text{Ci/ml}$).
7. Radionuclide evaluations of air samples should be employed in an effort to minimize the use of respiratory protection.

PART 6 Instrumentation Calibration and Performance Tests

561 Calibration

1. Radiological instruments shall be calibrated based on the guidance contained in ANSI N323, (1978). Calibrations shall be performed using sources and equipment with documented traceability links to National Institute of Standards and Technology (NIST).
2. Procedures, based upon Health Physics approved criteria, shall be developed for each instrument type and shall include frequency of calibration and any precalibration preventive maintenance requirements. M&TE calibration requirements, periodic performance test requirements, calibration record requirements, and maintenance requirements shall be addressed in separate procedures.
3. Appropriate guidance from ANSI N42.17 (1989) A, B, and C shall be used for instrument performance tests. All testing shall be performed based on Health Physics criteria and/or direct oversight.
4. As a minimum, instruments shall bear a label or tag with the date of calibration and the date due for recalibration.
5. Instruments that are out of calibration, damaged, or otherwise determined to be inoperable, shall not be used.
6. Calibrations shall only be performed by qualified personnel.
7. The Radiological Protection Manager shall designate subject matter experts and approve all training/certification modules for calibration personnel.

562 Maintenance

A program for preventive and corrective maintenance of radiological instrumentation shall be established and documented. Preventive and corrective maintenance shall be performed using components and procedural recommendations at least as stringent as those specified by the manufacturer of the instrument.

563 Calibration Facilities

Inspections, calibrations, performance tests, calibration equipment selection and quality assurance at calibration facilities shall be performed in accordance with the recommendations of ANSI N323, (1978).

Table 5-1 Non-Uniform Exposure of the Skin

Non-uniform exposures of the skin from x-rays, beta radiation and radioactive materials on the skin, including hot particles shall be assessed and recorded as specified in the table below for DOE personnel:

| AREA OF SKIN IRRADIATED | METHOD OR AVERAGING, ADDING TO OTHER DOSES RECEIVED, AND RECORDING NON-UNIFORM SKIN DOSE |
|-------------------------|---|
| $\geq 100 \text{ cm}^2$ | <p>Averaged over the 100 cm^2 of skin receiving the maximum dose</p> <p>Added to any uniform dose equivalent also received by the skin</p> <p>Recorded as the annual extremity or skin (shallow) dose equivalent (H)</p> |
| $< 100 \text{ cm}^2$ | <p>Averaged over the 1 cm^2 of skin receiving the maximum dose (D), reduced by the fraction (f) which is the irradiated area in cm^2 divided by 100 cm^2 (i.e. $H=fD$)</p> <p>Added to any uniform dose equivalent also received by the skin</p> <p>Recorded as the annual extremity or skin (shallow) dose equivalent</p> |
| $< 10 \text{ cm}^2$ | <p>Averaged over the 1 cm^2 of skin receiving the maximum dose</p> <p>Not added to any other dose equivalent, extremity or shallow dose equivalent (skin) recorded for the annual dose equivalent</p> <p>Recorded in a person's radiation dose record as a special entry</p> |

Chapter 6 TRAINING AND QUALIFICATION

| | <u>Page</u> |
|--|--------------------|
| PART 1 General Requirements | 57 |
| 611 Purpose | 57 |
| 612 Requirements | 57 |
| 613 Instructor Training and Qualifications | 58 |
| PART 2 General Employee Radiological Training | 58 |
| 621 Facility Personnel | 58 |
| 622 Radiological Orientation for Visitors | 59 |
| PART 3 Radiological Worker Training | 59 |
| 631 Requirements | 59 |
| 632 Specialized Radiological Worker Training | 59 |
| PART 4 Health Physics Technician Qualification | 59 |
| 641 Requirements | 59 |
| 642 Health Physics Technician | 60 |
| 643 Oral Examination Boards | 60 |
| 644 Continuing Training | 60 |
| 645 Health Physics Technician Supervisors | 61 |
| PART 5 Other Training | 61 |
| 651 Radiological Support Personnel | 61 |
| 652 Radiographers and Radiation Generating Device Operators | 61 |
| 653 Emergency Response Personnel | 61 |



3

Chapter 6 TRAINING AND QUALIFICATION

PART 1 General Requirements

611 Purpose

This chapter establishes the requirements to ensure that personnel have the training to work safely in and around radiological areas and to maintain individual internal and external radiation exposure to themselves and others ALARA. Training requirements in this chapter apply to all personnel at GDSs.

612 Requirements

Standardized core courses and training materials shall be used to achieve consistency. In establishing local training programs, the standardized core courses shall be presented and facility-specific information shall be added.

1. Standardized core course training material shall be used for General Employee Radiological Training, Radiological Worker Training, and Health Physics Technician Training.
2. Successful completion of approved courses for General Employee Radiological Training and Radiological Worker Training from other facilities may be recognized. Facility-specific training for General Employee Radiological Training and Radiological Worker Training may be included with other site orientation training.
3. The Radiological Protection Manager or a designee shall approve with facility-generated radiological training material.
4. Written examinations for General Employee Radiological Training, Radiological Worker Training and Health Physics Technician Training shall be used to demonstrate satisfactory completion of theoretical classroom and approved practical applications material.
5. Training should address both normal and abnormal situations in radiological control.
6. General Employee Radiological Training or Radiological Worker Training shall be continuously reevaluated. Changes to the program should be incorporated as they are identified and continuing retraining conducted commensurate with scope of program revisions. Radiological Workers are required to re-qualify every 2 years.
7. Facility-specific training and continuing training shall include changes and updates of lessons learned from operations and maintenance experience.

8. Verification of the effectiveness of radiological control training should be accomplished by surveying a limited subset of former students in the workplace. This verification is in addition to performance evaluations routinely performed by training departments. This evaluation should include observation of practical applications, discussions of the course material, and may include written examinations.
9. Reading and comprehension skills in the English language are necessary for General Employee Radiological Training. Visitor orientation and the use of trained escorts provide an alternate to training with the concurrence of the Health Physics Manager.
10. Standardized course material shall include the following topics:
 - a. Risks associated with exposure to radiation or radioactive material;
 - b. Precautions or procedures to minimize exposure;
 - c. Purposes and functions of personnel protective equipment;
 - d. Applicable provisions of regulations;
 - e. Responsibility to report conditions or events which may lead to or cause a violation or unnecessary exposure;
 - f. Appropriate responses to warnings alarms that may involve exposure;
 - g. The radiation exposure reports which workers may request.
11. The extent of the course material shall be commensurate with the potential for exposure.

613 Instructor Training and Qualifications

1. All instructors should be qualified in accordance with the facility Instructor Qualification Program or possess equivalent qualifications.
2. Instructors should have the technical knowledge, experience and instructional skills required to fulfill their assigned duties.
3. Instructors-in-training or Subject Matter Experts performing instructor functions shall be monitored by a qualified instructor.

PART 2 General Employee Radiological Training

621 Facility Personnel

Personnel who may routinely enter the Controlled Area and encounter radiological barriers, postings or radioactive materials shall receive General Employee Radiological Training. This training shall be successfully completed prior to potential occupational

radiation exposure. General Employee Radiological Training is a prerequisite for Radiological Worker Training, unless Radiological Worker Training is performed as part of initial indoctrination.

622 Radiological Orientation for Visitors

1. Visitors who enter the Controlled Area shall receive a radiological safety orientation.
2. Records of the orientation shall be maintained.
3. The orientation for continuously escorted individuals or groups should be commensurate with the areas to be visited.

PART 3 Radiological Worker Training

631 Requirements

1. Workers whose job assignments require access to Restricted Areas shall complete Radiological Worker training before being permitted to enter these areas without a qualified escort.
2. Specific training is required for special job functions with radiological consequences.
3. Radiological Worker Training shall use standardized core course training materials in addition to facility-specific information.

632 Specialized Radiological Worker Training

Specialized Radiological Worker training shall be conducted for jobs such as those that use special containment devices, the use of mockups and ALARA considerations, etc. The Radiological Protection Manager shall determine when Specialized Radiation Worker Training is required.

PART 4 Health Physics Technician Qualification

641 Requirements

Training and qualification of Health Physics Technicians and their immediate supervisors shall address routine operations, and also focus on recognizing and handling situations in both routine and changing radiological conditions. Newly qualified technicians and those still in training should be given the opportunity to work with qualified, experienced technicians to foster development.

642 Health Physics Technician

1. Health Physics Technician qualification consists of the standardized core course training material, facility specific information, on-the-job training, and passing a final comprehensive written examination and a final oral examination if required by Article 643.
2. Formal remediation protocols shall be established to ensure Health Physics Technicians maintain qualifications.
3. Entry-level prerequisites shall be established to ensure that Health Physics Technicians meet standards for physical condition and education.
4. Task Qualification for entry level positions may be used until formal training is completed.

643 Oral Examination Boards

Oral Examination Boards for qualification of Health Physics personnel shall comply with the following:

1. The Health Physics Manager or a designee shall designate the Board members and appoint a Chairperson.
2. The Board constituted to evaluate Health Physics Technician qualification should be composed of at least three persons including a Health Physics Technician Supervisor and Health Physics staff.
3. The Board shall assess the candidate's response to normal and emergency situations.
4. The Board constituted to evaluate Health Physics Technician Supervisor qualification shall not include peers or subordinates as voting members.

644 Continuing Training

1. Following initial qualification, Health Physics Technicians, shall be requalified every 2-years. The requalification process requires comprehensive written and/or oral examinations.
2. Personnel who maintain qualifications as Health Physics Technicians satisfy the requirements of Radiological Worker training.

645 Health Physics Technician Supervisors

1. Health Physics Technician Supervisors shall have qualified as Health Physics Technicians and should participate in continuing radiological training programs. A Health Physics Technician Supervisor's depth of knowledge shall be expected to exceed that of a Health Physics Technician.
2. Health Physics Technician Supervisors should have supervisory and leadership capabilities to direct the work of technicians; effectively interact with crafts, line supervisors, professional staff and other managers. They shall be able to respond and direct others in emergency and abnormal situations.
3. Health Physics Technician Supervisors shall be requalified every 2 years through a written examination and/or oral examination.

PART 5 Other Training

651 Radiological Support Personnel

Radiological support personnel shall have:

1. Training on standardized core course topics from Radiological Worker and Health Physics Technician training and additional job-specific topics, as applicable;
2. Training appropriate to the tasks to be performed;
3. Continuing training to provide continued improvement in knowledge and skills.

652 Radiographers and Radiation Generating Device Operators

Radiographers shall have training in accordance with 10 CFR 34.31. Radiation Generating Device Operators should have training comparable to that required by 10 CFR 34.31.

653 Emergency Response Personnel

Provisions shall be in place to accommodate rapid facility and radiological area access by on-site and off-site emergency workers such as firefighters, medical personnel, and security personnel.

Chapter 7 RADIOLOGICAL RECORDS

| | <u>Page</u> |
|---|-------------|
| PART 1 | |
| Requirements | 65 |
| 711 Purpose | 65 |
| 712 Records Management Program | 65 |
| 713 Recordkeeping Standards | 66 |
| PART 2 | |
| Employee Records | 66 |
| 721 Personnel Radiological Records | 66 |
| 722 Other Personnel Radiological Records | 66 |
| 723 Radiological Training and Qualification Records | 66 |
| PART 3 | |
| Visitors Records | 67 |
| PART 4 | |
| Records Management | 67 |
| 741 Media | 67 |
| 742 Computerization of Records | 67 |
| 743 Retention | 67 |
| 744 Physical Protection of Records | 67 |
| PART 5 | |
| Radiological Reporting | 68 |
| 751 Reports to Individuals | 68 |
| 752 Annual Radiation Report | 68 |

Chapter 7 RADIOLOGICAL RECORDS

PART 1 Requirements

711 Purpose

Radiological Protection records are needed to demonstrate the effectiveness of the overall program. Records are required to document radiological safety afforded to facility personnel. Records of radiological programs may be required to support worker health studies and future disputes or claims.

712 Records Management Program

1. A Radiological Records Management program shall be established. This program shall ensure that auditable records and reports are controlled through the stages of creation, distribution, use, arrangement, storage, retrieval, media conversion (if applicable) and disposition. The records management program should include the following:
 - a. Radiological Policy Statements;
 - b. Radiological Protection Procedures;
 - c. Individual Radiological Total Effective Dose Equivalents;
 - d. Internal and External Dosimetry Policies and Procedures (including Technical Basis Documents);
 - e. Personnel Training (course records and individual records);
 - f. ALARA Records;
 - g. Radiological Instrumentation Test, Repair and Calibration Records;
 - h. Radiological Surveys;
 - i. Monitoring Results;
 - j. Radiological Work Permits;
 - k. Radiological Performance Indicators and Assessments;
 - l. Quality Assurance Records;
 - m. Radiological Incident and Occurrence Reports (and Critique Reports, if applicable);
 - n. Accountability records for sealed sources;
 - o. Reports of loss of radioactive material.
2. When radiological services (for example, dosimetry and laboratory analyses) are purchased, there should be a clear agreement regarding records responsibility during performance of the service.
3. Individual records shall be maintained in accordance with The Privacy Act of 1974.

713 Recordkeeping Standards

1. Radiological Protection records shall be accurate and legible. Subpart H of 10 CFR 835 shall apply to DOE records and subpart L of 10 CFR 20 shall apply to NRC records. The records should include the following:
 - a. Identification of the facility, specific location, function and process;
 - b. Signature or other identifying code of the preparer and date;
 - c. Legible entries in black ink;
 - d. Corrections identified by a single line-out, initialed and dated;
 - e. Supervisory signature to ensure review and proper completion of forms.
2. The Health Physics Organization should maintain a file of names, signatures and initials for future identification of the person who signed or initialed a record.
3. Radiological Control records should not include:
 - a. Opaque substances for corrections;
 - b. Shorthand or other nonstandardized terms.
4. Similar procedural standards should be established for computerized records.

PART 2 Employee Records

721 Personnel Radiological Records

Radiation dose records shall be maintained for all personnel who are part of the personnel dosimetry program. Radiation dose records shall contain information sufficient to identify each person, including social security or employee number.

722 Other Personnel Radiological Records

The complete records of radiological incidents and occurrences involving personnel dose shall be retained. Records of employee radiological safety concerns that have been formally investigated and documented should be maintained.

723 Radiological Training and Qualification Records

Records of training and qualification in radiological protection shall be maintained to demonstrate that a person received appropriate information to perform the work assignment safely.

PART 3 Visitors Records

For visitors entering an area where personnel monitoring is required, the following records shall be maintained:

1. Documentation of completion of Radiological Orientation.
2. Radiation dose records, including zero dose.

PART 4 Records Management

741 Media

A combination of media may be used for a comprehensive records system. For records that have long-term retention requirements and are stored on media subject to degradation or obsolescence, the record's system shall provide for conversion to a more stable medium. All records shall be stored in a manner that ensures their integrity, retrievability, and security.

742 Computerization of Records

Records may be transferred to magnetic or optical storage media provided precautions are taken to ensure that the information is maintained in a retrievable configuration.

743 Retention

Once a record has been created, reviewed and signed by appropriate supervision, the record is considered complete and shall not be modified. Subsequent errors identified in a completed record may be corrected by creating a supplemental record that includes traceability for the correction.

744 Physical Protection of Records

1. Methods for protecting documents should include vaults, file rooms with fixed fire suppression, fire rated cabinets, duplicate storage, or combinations of these.
2. Storage arrangements should address physical damage that could be caused by temperature extremes, moisture, infestation, electromagnetic fields, excessive light, stacking, theft and vandalism.

3. Records should, as a minimum, be protected from:
 - a. Exposure to fire, equivalent to an Underwriters Laboratories, Inc., 1.5-hour, or greater, fire resistance rating;
 - b. Exposure to water damage caused by a 100-year flood;
 - c. Exposure to windstorm velocities of 100-year recurrence.

PART 5 Radiological Reporting

751 Reports to Individuals

Personnel who are monitored by the personnel dosimetry program shall be provided an annual report of their total effective dose equivalent.

1. Upon written request, any monitored individual shall be provided, within 30 days of receipt of the request or within 30 days after the data becomes available, whichever is later, a summary of their total effective dose equivalent for each prior year monitoring was required.
2. Termination reports shall be provided to a worker or designee for the current year or fraction of the current year. An estimate of current year dose will be provided if actual data is unavailable.

752 Annual Radiation Report

An "Annual Radiation Dose Summary", which includes internal and external radiation dose results for monitored employees, and for monitored visitors, shall be documented.

REFERENCES

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

ICRP Publication 23 "Reference Man Anatomical Physiological and Metabolic Characteristics."

ICRP Publication 26 "Recommendation of the International Commission on Radiological Protection."

ICRP Publication 30 "Limits for Intakes of Radionuclides by Workers."

NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS

NCRP Report No. 53 "Review of NCRP Dose Limit for Embryo and Fetus in Occupationally Exposed Women."

NCRP Report No. 59 "Operational Radiation Safety Program."

NCRP Report No. 61 "Radiation Safety Training Criteria for Industrial Radiography."

NCRP Report No. 65 "Management of Persons Accidentally Contaminated with Radionuclides."

NCRP Report No. 91 "Recommendations on Limits for Exposure to Ionizing Radiation."

FEDERAL

FR 87-1716 "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," signed by President Reagan, January 20, 1987.

10 CFR 19 "Notices, Instructions, and Reports to Workers: Inspections and Investigations"

10 CFR 20 "Standards for Protection Against Radiation."

10 CFR 30 "Rules of General Applicability to Domestic Licensing of Byproduct Material"

10 CFR 34 "Licenses for Radiography and Radiation Safety Requirements for Radiographic Operations."

10 CFR 34.31 "Personal Radiation Safety Requirements for Radiographers and Radiographers Assistants - Training."

10 CFR 40 "Domestic Licensing of Source Material"

10 CFR 835 "Occupational Radiation Protection"

29 CFR 1910 "Occupational Safety and Health Standards."

29 CFR 1910.134 "General Industry Standards - Respiratory Protection."

49 CFR 172 "Hazardous Materials Tables, Hazardous Materials Communications, Requirements and Emergency Response Information Requirements."

49 CFR 173 "Shippers - General Requirements for Shipments and Packaging."

GUIDES TO GOOD PRACTICES

EGG-2530 "Health Physics Manual of Good Practices for Uranium Facilities," EG&G, Idaho Falls, Idaho 83415.

PNL-6577 "Health Physics Manual of Good Practices to Reducing Radiation Exposure to Levels that Are As Low As Reasonably Achievable (ALARA)," Pacific Northwest Laboratory, Richland, Washington 99352.

TAP 1-88, 2-88, 3-88 "Training Accreditation Manuals," Training Resources and Data Exchange (TRADE), Oak Ridge Associated Universities, Oak Ridge, Tennessee 37831.

AMERICAN NATIONAL STANDARDS INSTITUTE

CGA G-7.1 "Commodity Specification for Air."

UL586 "High Efficiency Particulate Air Units."

Z88.2 "Practices for Respiratory Protection."

Z88.6 "Physical Qualifications for Respirator Use."

N2.1 "Radiation Symbol."

N3.1 "Selection, Qualification and Training of Personnel for Nuclear Power Plants."

N12.1 "Fissile Material Symbol."

N13.1 "Guide to Sampling Airborne Radioactive Material in a Nuclear Facility."

N13.5 "Performance Specification for Direct Reading and Indirect Reading Pocket Dosimeters for X- and Gamma Radiation."

N13.6 "Practice for Occupational Radiation Exposure Record Systems," (Reaffirmed in 1982).

N13.11 "Personnel Dosimetry Performance - Criteria for Testing."

N42.17A "Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for use in Normal Environmental Conditions."

N42.17B "Performance Specifications for Health Physics Instrumentation - Occupational Airborne Radioactivity Monitoring Instrumentation."

N42.17C "Performance Specifications for Health Physics Instrumentation - Portable Instrumentation for use in Extreme Environmental Conditions."

N43.2 "Radiation Safety for X-ray Diffraction and Fluorescence Analysis Equipment."

N319 "Personal Neutron Dosimeters (Neutron Energies Less Than 20 MeV)."

N323 "Radiation Protection Instrumentation Test and Calibration"

N542 "Sealed Radioactive Sources, Classification"

N543 "General Safety Standard for Installation Using Nonmedical X-ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV."

TECHNICAL BASIS DOCUMENTS

PNL-8723, "Internal Dosimetry Technical Basis Manual for Portsmouth and Paducah Gaseous Diffusion Plants"

UEO-1003, "Uranium Enrichment Air Monitoring Technical Basis Document"

GLOSSARY

Administrative Control Level: Level of radiation exposure established well below regulatory limits by management to help reduce individual and collective radiation dose.

airborne radioactivity: Radioactive material in any chemical or physical form that is present in ambient air, above natural background.

Airborne Radioactivity Area: Area where the measured concentration of airborne radioactivity, above natural background, exceeds either: (1) 10 percent of the Derived Air Concentration (DAC) averaged over 8 hours or (2) a peak concentration of 1 DAC.

Annual Limit on Intake (ALI): The quantity of a single radionuclide that, if inhaled or ingested in 1 year, would irradiate a person, represented by reference man (ICRP Publication 23), to the limiting value for control of occupational exposure.

Anti-C clothing: Clothing provided to personnel to minimize the potential for skin and personal clothing contamination. Also referred to as "anti-contamination clothing," "anti-Cs" and "PCs."

As Low As Reasonably Achievable (ALARA): An approach to radiological control to manage and control exposures (individual and collective) to the work force and to the general public at levels as low as is reasonably achievable, taking into account social, technical, economic, practical and public policy considerations. As used in this Manual, ALARA is not a dose limit but a philosophy that has the objective of attaining doses as far below the applicable controlling limits as is reasonably achievable.

ALARA Committee: Multi-disciplined forum that reviews and advises management on improving progress toward minimizing radiation exposure and radiological releases.

assessment: Evaluation or appraisal of a process, program or activity to estimate its acceptability.

bioassay: Measurement of radioactive material deposited within or excreted from the body. This process may include whole body and organ counting as well as urine, fecal, or other specimen analysis.

company-issued clothing: Clothing provided by the company, such as work coveralls and shoes. For radiological control purposes, company-issued clothing shall be considered the same as personal clothing.

containment device: Barrier such as a glovebag, glovebox or tent for inhibiting the release of radioactive material from a specific location.

critical mass: The smallest mass of fissionable material that will support a self-sustaining chain reaction under specified conditions.

Contamination Area: Area where contamination levels are greater than the values specified in, Table 2-2, but less than or equal to 50 times those levels.

Contamination Control Zone: An area where transferable contamination levels are less than the release limits stated in Table 2-2. Contamination Control Zones are essentially buffer zones established where discreet areas of contamination may be occasionally encountered as a result of facility size and historical operation.

contamination survey: Use of swipes or direct instrument surveys to identify and quantify radioactive material on personnel, on equipment or in areas.

continuing training: Training scheduled over a specified time such as over a two-year period for the purpose of maintaining and improving technical knowledge and skills.

continuous air monitor (CAM): Instrument that continuously samples and measures the levels of airborne radioactive materials on a "real-time" basis and has alarm capabilities at preset levels.

Controlled Area: An area outside the Restricted Area but inside the site boundary, access to which can be limited for any reason.

counseling: Advice, information exchange and guidance provided to employees on radiologically related topics, such as dose perspectives; potential health effects from radiation exposure; skin contaminations; contaminated wounds; internally deposited radioactivity; pregnancy; and radiation exposure. This advice and guidance are normally provided by knowledgeable, senior professionals from the Health Physics Organization and other organizations, such as Medical, as appropriate.

critique: Meetings of personnel involved in or knowledgeable about an event (either a success or an abnormal event) to document a chronological listing of the facts.

Curie: A unit of radioactivity. One curie is equal to 3.7×10^{10} disintegrations per second, which also equals 2.2×10^{12} disintegrations per minute.

declared pregnant worker: A woman who has voluntarily informed her employer, in writing, of her pregnancy and the estimated date of conception.

decontamination: Process of removing radioactive contamination and materials from personnel, equipment or areas.

deep dose: The dose equivalent from external radiation determined at a tissue depth of 1 cm.

Derived Air Concentration (DAC): The concentration of a radionuclide in air that, if breathed over the period of a work year, would result in the ALI for that radionuclide being reached. The DAC is obtained by dividing the ALI by the volume of air breathed by an average worker during a working year (2400 m³).

disintegration per minute (dpm): The rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

dose: The amount of energy deposited in body tissue due to radiation exposure. Various technical terms, such as dose equivalent, effective dose equivalent and collective dose, are used to evaluate the amount of radiation an exposed worker receives. These terms are used to describe the differing interactions of radiation with tissue as well as to assist in the management of personnel exposure to radiation.

Some types of radiation, such as neutron and alpha, deposit their energy more densely in effected tissue than gamma radiation and thereby causing more damage to tissue. The term **dose equivalent**, measured in units of rem, is used to take into account this difference in tissue damage. Therefore 1 rem from gamma radiation causes damage **equivalent** to 1 rem from alpha radiation. However, it takes one-twentieth as much energy from alpha radiation, as compared with gamma radiation, to produce this 1 rem **dose equivalent**.

The term **collective dose**, measured in person-rem, is calculated by summing the dose to each person in the group of interest. For example, if 12 workers each have 1 rem, then the collective dose is 12 person-rem.

Technical definitions for dose terms necessary for various exposure calculations and recordkeeping purposes include the following:

absorbed dose (D): Energy imparted to matter by ionizing radiation per unit mass of irradiated material at the place of interest in that material. The units of absorbed dose are the rad.

dose equivalent (H_T): The product of the absorbed dose in tissue, quality factor, and all other necessary modifying factors at the location of interest. The units of dose equivalent are the rem.

effective dose equivalent (H_E): The sum of the products of the dose equivalent to the organ or tissue (H_T) and the weighing factors

(W_T) applicable to each of the body organs or tissues that are irradiated ($H_E = \sum W_T H_T$).

committed dose equivalent ($H_{T,50}$): The dose equivalent to organs or tissues of reference (T) that will be received from an intake of radioactive material by a person during the 50-year period following the intake.

committed effective dose equivalent ($H_{E,50}$): The sum of the products of the weighing factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues ($H_{E,50} = \sum W_T H_{T,50}$).

total effective dose equivalent (TEDE): The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

weighing factor: Factor that represents the proportion of the total stochastic (cancer plus genetic) risk resulting from irradiation to tissue to the total risk when the whole body is irradiated uniformly.

dose assessment: Process of determining radiological dose and uncertainty included in the dose estimate, through the use of exposure scenarios, bioassay results, monitoring data, source term information and pathway analysis.

embryo/fetus: Developing human organism from conception until birth. Same as unborn child.

engineering controls: Use of components and systems to reduce airborne radioactivity and the spread of contamination by using piping, containments, ventilation, filtration or shielding.

extremities: Includes hands and feet, arms below the elbow and legs below the knee.

eye dose equivalent: Applies to the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 cm.

filter integrity test: Test performed on High-Efficiency Particulate Air (HEPA) filters to identify any damage to the filter or leakage around the filter. Techniques used to conduct the test are described in ANSI/UL 586-1990, "High Efficiency Particulate Air Units."

fixed contamination: Radioactive material that cannot be readily removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or washing.

frisk or frisking: Process of monitoring personnel for contamination. Frisking can be performed with hand-held survey instruments, automated monitoring devices or by a Radiological Control Technician.

Gaseous Diffusion Site (GDS): DOE properties primarily located in Pike County, Ohio and McCracken County, Kentucky traditionally associated with gaseous diffusion.

gestation period: The time from conception to birth, approximately 9 months.

High-Efficiency Particulate Air (HEPA) filter: Throwaway extended pleated medium dry-type filter with 1) a rigid casing enclosing the full depth of the pleats, 2) a minimum particle removal efficiency of 99.97 percent for thermally generated monodisperse DOP smoke particles with a diameter of 0.3 micrometer, and 3) a maximum pressure drop of 1.0 inch w.g. when clean and operated at its rated airflow capacity.

High Contamination Area: Area where contamination levels are greater than 50 times the values specified in, Table 2-2, of this Manual.

High Radiation Area: An area, accessible to personnel, in which radiation levels could result in a person receiving a dose equivalent in excess of 0.1 rem in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

infrequent or first-time activities: Radiological work activities or operations that require special management attention and consideration of new or novel radiological controls. The designation of infrequent or first-time activities is specifically applicable to facilities that conduct routine and recurring process operations, and is not applicable to facilities that routinely conduct first-time activities, such as experimental or research facilities.

lifetime dose: Total occupational exposure over a worker's lifetime, including external and committed internal dose.

nuclear criticality: a self-sustaining chain reaction, i.e., the state in which the effective neutron multiplication constant of system of fissionable material equals or exceeds unity.

occupational dose: The dose received by a person during employment in which the person's assigned duties involve exposure to radiation and to radioactive material. Occupational dose does not include dose received from background radiation, as a patient from medical practices, from voluntary participation in medical research programs, or as a member of the public.

personnel dosimetry: Devices designed to be worn by a single person for the assessment of dose equivalent such as film badges, thermoluminescent dosimeters (TLDs), and pocket ionization chambers.

personnel monitoring: Systematic and periodic estimate of radiation dose received by personnel during working hours. Also, the monitoring of personnel, their excretions, skin or any part of their clothing to determine the amount of radioactivity present.

Personal Protective Equipment: Equipment such as respirators, face shields, clothing, and safety glasses used to protect workers from unnecessary exposure to radioactive or hazardous materials.

Planned Special Exposure: Preplanned, infrequent exposure to radiation, separate from and in addition to the annual dose limits.

Plant Manager: The individual who has final on-site corporate authority.

primary dosimeter: A dosimeter worn on the body used to obtain the formal record of whole body radiation dose.

Qualification Standard: A document that states and defines the required physical attributes and the technical, academic and practical knowledge and skills developed through training, education and on-the-job performance for the successful completion of a training program.

rad: Unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs per gram or 0.01 joules per kilogram.

Radiation Area: An area, accessible to personnel, in which radiation levels could result in a person receiving a dose equivalent in excess of 0.005 rem in 1 hour at 30 centimeters from the source or from any surface that the radiation penetrates.

radiation survey: Measurement with instrumentation to evaluate and assess the presence of radioactive materials or other sources of radiation under a specific set of conditions.

radioactive material: Radioactive material includes any material, equipment or system component determined to be contaminated or suspected of being contaminated. Radioactive material also includes activated material, sealed and unsealed sources, and material that emits radiation.

Radioactive Material Area: An area or structure where radioactive material is used, handled or stored.

radioactive waste: Solid, liquid or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, and is of negligible economic value considering the cost of recovery.

radioactivity: A natural and spontaneous process by which the unstable atoms of an element emit or radiate excess energy from their nuclei and, thus, change (or decay) to atoms of a different element or to a lower energy state of the same element.

radiography: Examination of the structure of materials by nondestructive methods, using a radioactive source or a radiation generating device.

radiological area: A collective term referring to any of the following:

1. Radiation Area
2. High Radiation Area
3. Very High Radiation Area
4. Contamination Control Zone
5. Contamination Area
6. High Contamination Area
7. Airborne Radioactivity Area
8. Fixed Surface Contamination Area
9. Radioactive Material Area

radiological posting: Sign or label that indicates the presence or potential presence of radiation or radioactive materials.

Radiological Protection Manager (RPM): The individual responsible for the radiological protection program as appointed by the Plant Manager.

radiological work: Any work that requires the handling of radioactive material or which requires access to Radiation Areas, High Radiation Areas, Contamination Control Zones, Contamination Areas, High Contamination Areas or Airborne Radioactivity Areas.

Radiological Work Permit (RWP): A permit which identifies radiological conditions, establishes worker protection and monitoring requirements, and contains specific approvals for radiological work activities. The RWP serves as an administrative process for planning and controlling radiological work, informing the worker of the radiological conditions and maintaining exposure ALARA.

radiological worker: Worker whose job assignment requires work on, with, or in the proximity of radiation producing machines or radioactive materials. A "radiological worker" may also be referred to as a "radiation worker" or a "radworker."

Radiological Hold Point: Cautionary step(s) in a Technical Work Document or Radiological Work Permit (RWP) requiring Health Physics to perform an action or verification prior to continuing work.

refresher training: Training scheduled on the alternate year when full retraining is not completed for Radiological Worker personnel.

release survey: Monitoring performed by Health Physics to determine if equipment or items may be removed from a Radiological or Controlled Area.

rem: Unit of dose equivalent. Dose equivalent in rem is numerically equal to the absorbed dose in rad multiplied by a quality factor, distribution factor and any other necessary modifying factor.

removable contamination: Radioactive material that can be removed from surfaces by nondestructive means, such as casual contact, wiping, brushing or washing.

respiratory protective equipment: Equipment used to protect personnel from inhalation of radioactive or hazardous materials.

Restricted Area: An area, to which access is limited for the purpose of protecting individuals against undue risk from exposure to radiation and radioactive materials and requires a TLD for entry.

shallow dose equivalent: Applies to the external exposure of the skin or an extremity. It is taken as the dose equivalent at a tissue depth of 0.007 centimeter.

source, sealed: Radioactive material that is contained in a sealed capsule, sealed between layers of nonradioactive material or firmly fixed to a nonradioactive surface by electroplating or other means. The confining barrier prevents dispersion of the radioactive material under normal and most accidental conditions related to use of the source.

source, unsealed: Radioactive material that is unencapsulated (i.e., liquid calibration standards) that shall be controlled as radioactive material.

step-off pad: Transition area between contaminated and non-contaminated areas that is used to allow exit of personnel and removal of equipment.

standard radiation symbol: Symbols designed and proportioned as illustrated in accordance with ANSI N2.1 for radiation symbols and ANSI N12.1 for fissile material.

sticky pad: Step-off pad provided with a tacky surface to reduce the potential for inadvertently tracking contamination out of a contaminated area.

technical work document: A term used to generically identify formally approved documents that direct work, such as procedures, work packages, or job or research plans.

thermoluminescent dosimeter (TLD): Radiation monitoring device issued by Health Physics used to record the radiological exposure of personnel or areas to certain types of radiation.

Very High Radiation Area: An area, accessible to personnel, in which radiation levels could result in a person receiving an absorbed dose in excess of 500 rads in one hour at 1 meter from a radiation source or from any surface that the radiation penetrates.

visitor: Person requesting access to Restricted Areas, who has not been trained to the level required to permit unescorted access.

whole body dose: The sum of the annual deep dose equivalent for external exposures and the committed effective dose equivalent for internal exposures.